Class VI Injection Well: Quality Assurance and Surveillance Plan

CLEAN ENERGY SYSTEMS MENDOTA

These documents were prepared by Schlumberger and delivered to Clean Energy Systems

Plan Revision Number: 1.1

Plan Revision Date: June 14, 2021

Plan revision number: 1.1
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Table of Contents

Plan revision number: 1.1
Plan revision date: June 14, 2021

List of Tables

List of Figures

Title and Approval Sheet

This Quality Assurance and Surveillance Plan (QASP) is approved for use and implementation at Clean Energy Systems Mendota. The signatures below denote the approval of this document and intent to abide by the procedures outlined within it.

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Distribution List

The following project participants will receive the completed Quality Assurance and Surveillance Plan (QASP) and all future updates for the duration of the project.

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A. Project Management

A.1. Project/Task Organization

A.1.a/b. Key Individuals and Responsibilities

The project, led by Clean Energy Systems (CES), includes participation from several subcontractors. The Testing and Monitoring Activities responsibilities will be shared between CES and their designated subcontractors and the program will be broken in six subcategories:

I. Shallow Groundwater Sampling
II. Deep Groundwater Sampling
III. Well Logging
IV. Mechanical Integrity Testing (MIT)
V. Pressure/Temperature Monitoring
VI. CO2 Stream Analysis
VII. Geophysical Monitoring

A.1.c. Independence from Project QA Manager and Data Gathering

The majority of the physical samples collected and data gathered as part of the monitoring, verification, and accounting (MVA) program will be analyzed, processed, or witnessed by third parties independent and outside of the project management structure.

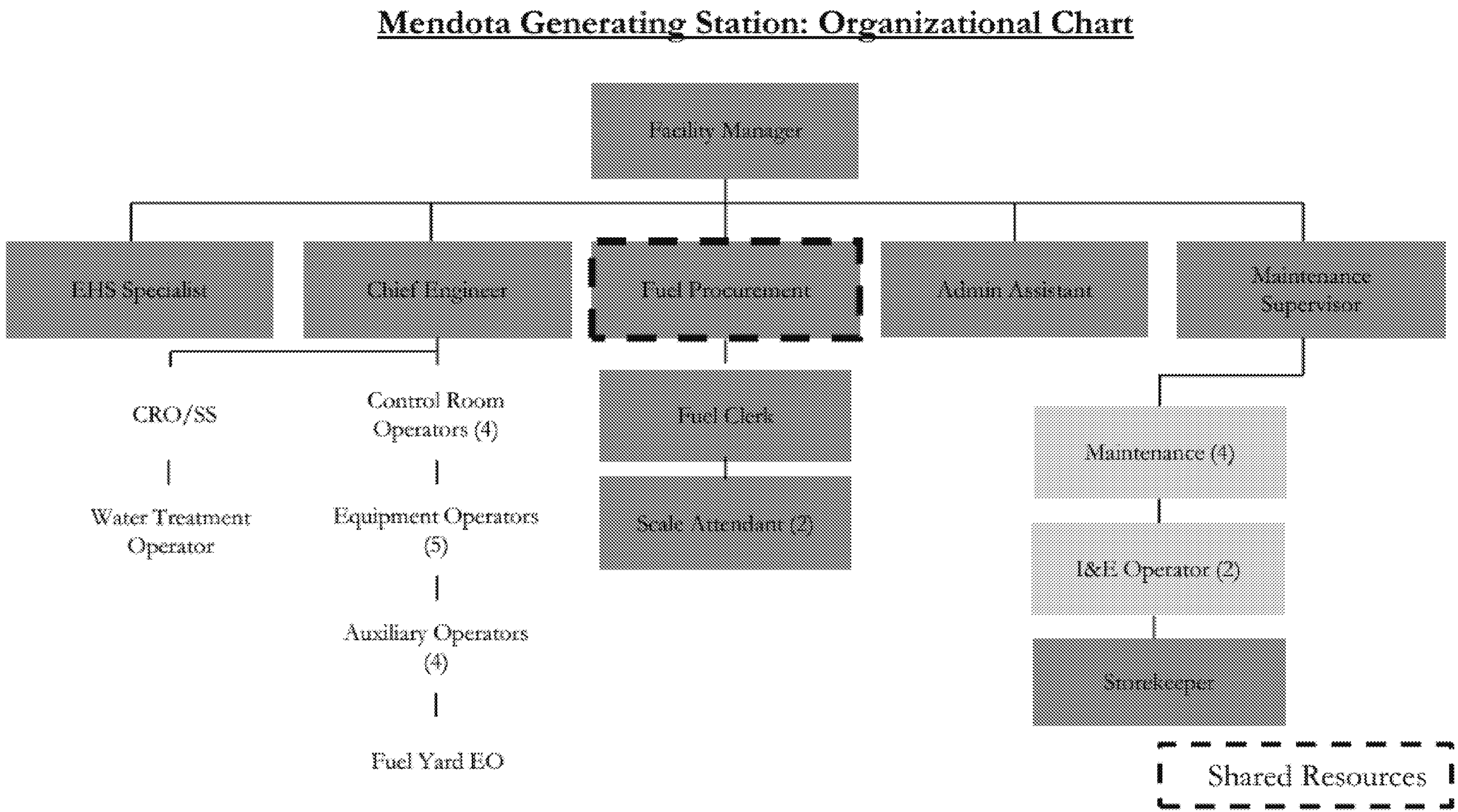
A.1.d. QA Project Plan Responsibility

CES will be responsible for maintaining and distributing the official and approved Quality Assurance and Surveillance Plan (QASP). CES will periodically review this QASP and consult with the EPA if/when changes to the plan are warranted.

A.1.e. Organizational Chart for Key Project Personnel

Figure 1 shows the organization structure of the project. CES will provide to the UIC Program Director a contact list of individuals fulfilling these roles.

Figure 1. Clean Energy Systems project organization structure.



A.2. Problem Definition/Background

A.2.a. Reasoning

The Clean Energy System Carbon Capture and Storage (CES-CCS) Project's MVA program has operational monitoring, verification, and environmental monitoring components. Operational monitoring is used to ensure safety with all procedures associated with fluid injection, monitoring the response of storage unit, and the movement of the CO_2 plume. Key monitoring parameters include the pressure of injection well tubing & annulus, storage unit, above seal strata, and the lowermost USDW reservoir. Other monitoring parameters include injection rate, total mass & volume injected, injection well temperature profile, and passive seismic. The verification component will provide information to evaluate if leakage of CO_2 through the caprock is occurring. This includes pulse neutron logging, pressure, and temperature monitoring. The environmental monitoring components will determine if the injectate is being released into the shallow subsurface or biosphere. This monitoring includes pulse neutron logging and ground water monitoring.

A robust MVA program has been developed for the CES-CCS project. The primary goal of the CES-CCS MVA program is to safely store CO_2 byproduct from the Carbon Negative Energy (CNE) plant and ensure project activities are protective of human health and the environment. To help achieve this goal, this QASP was developed to insure the quality standards of the testing and monitoring program meet the requirements of the U.S. Environmental Protection Agency's (USEPA) Underground Injection Control (UIC) Program for Class VI wells.

A.2.b. Reasons for Initiating the Project

The goal of the CES-CCS injection project is to capture and store the CO_2 byproduct from the CNE plant at Mendota. The CNE plant uses biomass as feedstock to produce syngas, which passes through a gas separation unit to produce renewable hydrogen for transportation fuel. The hydrogen-depleted syngas then passes through CES' proprietary gas generator to produce a pure stream of high-pressure CO_2. CES plans to compress this CO_2 to a supercritical state and inject it deep into the subsurface for geologic sequestration (GS) in the Panoche formation for permanent geologic sequestration to reduce atmospheric concentrations of CO_2. The anticipated mass to be captured and injected is 350,000 tonnes/year over the next twelve (4,200,000 tonnes total) to twenty years (7,000,000 tonnes total). A rigorous MVA plan is proposed to ensure the injected CO_2 is retained within the intended storage reservoir.

A.2.c. Regulatory Information, Applicable Criteria, Action Limits

A.3. Project/Task Description

A.3.a/b. Summary of Work to be Performed

Table 1 describes the testing and monitoring tasks, reasoning, responsible parties, locations and testing frequency. Table 2 and Table 3 summarize the instrumentation and geophysical surveys, respectively. Attachment C: Testing and Monitoring Plan 40 CFR 146.90 Clean Energy Systems Mendota (Schlumberger, 2021c) has the monitoring schedule for the activities listed in Table 1, Table 2, and Table 3.

Table 1. Summary of Testing and Monitoring

Activity	Location(s)	Method	Analytical Technique	Laboratory/Custody	Purpose
Carbon dioxide stream analysis	Compressor	Direct Sampling	Chemical analysis	TBD	Monitor injectate
Injection rate and volume	After compression	Flow Meter	Direct measurement	N/A	Monitor injectate rate and volume
Corrosion monitoring	After compression	Coupon	Physical analysis	N/A	Monitor well integrity
Injection pressure / temperature	Mendota_INJ_1 wellhead	Pressure / temperature gauge	Direct measurement	N/A	Monitor injection pressure and temperature / well integrity
Annular pressure	Mendota_INJ_1 wellhead	Pressure gauge	Direct measurement	N/A	Monitor annular pressure / well integrity
Annular fluid volume	Mendota_INJ_1 wellhead	Gauge	Direct measurement	N/A	Monitor annular fluid volume / well integrity
Downhole pressure/ temperature	Mendota_INJ_1:Second Panoche injection formation	Downhole gauge	Direct measurement	N/A	Monitor reservoir pressure / injection temperature / well integrity
Downhole pressure/ temperature	Mendota_OBS_1_1: First, Second, and Third Panoche sands	Downhole gauge	Direct measurement	N/A	Monitor CO_2 plume migration and reservoir integrity
Mechanical integrity	Mendota_INJ_1 Mendota_OBS_1 Mendota_ACZ_1 wellbores	Various per Att C: External Mechanical Testing	146.87 (a) (4) & 146.89 (c)(2)	N/A	Monitor well integrity
DAS fiber optic acoustic & temperature	Mendota INJ_1_wellbore	Fiber optic cable	Direct measurement	N/A	Monitor wellbore integrity and microseismicity / reservoir integrity

Activity	Location(s)	Method	Analytical Technique	Laboratory/Custody	Purpose
Cement evaluation	Mendota_INJ_1 Mendota_OBS_1 Mendota_ACZ_1 wellbores	Sonic / ultrasonic logging	Cement evaluation log	N/A	Monitor wellbore integrity
Pressure falloff testing	Panoche formation	Pressure gauge	Direct measurement	N/A	Reservoir integrity
Microseismic	Mendota_ACZ_1 Mendota_OBS_1 Various	Multilevel geophones and seismometers	Direct measurement	N/A	Monitor reservoir integrity
Sampling	Shallow ground water wells (GW1, GW2, GW3, GW4)	Swab or other method	Chemical analysis	TBD	Monitor ground water
Sampling	Mendota_USDW_1 Deepest USDW	Swab or other method	Chemical analysis	TBD	Monitor deepest USDW
DAS Fiber Optic Acoustic & Temperature	Mendota_ACZ_1 Wellbore	Fiber optic cable	Direct measurement	N/A	Wellbore integrity and microseismicity / reservoir integrity
Sampling	Mendota_ACZ_1 Permeable formation above main seal	Swab or other method	Chemical analysis	TBD	Monitor above confining zone water / Well and reservoir integrity
Pulsed neutron	Mendota_ACZ_1	Survey Log	Indirect measurement	N/A	Monitor CO_2 plume migration / Well and reservoir integrity
DAS fiber optic acoustic & temperature	Mendota_OBS_1 Wellbore	Fiber optic cable	Direct measurement	N/A	Monitor Wellbore integrity and microseismicity / Reservoir Integrity
Sampling	Mendota_OBS_1 Second Panoche sand	Swab or other method	Chemical analysis	TBD	Monitor CO_2 plume migration / plume migration
Pulsed neutron	Mendota_OBS_1	Survey Log	Indirect measurement	N/A	Monitor CO_2 plume migration / Well and reservoir integrity

Activity	Location(s)	Method	Analytical Technique	Laboratory/Custody	Purpose
Time-lapse VSP	Mendota_OBS_1	Multilevel geophones and seismometers	Indirect measurement	N/A	Monitor CO_2 plume migration and reservoir integrity
3D surface seismic survey, or combination surface and well VSP	Full coverage focusing on the northern extent of plume area	Multilevel geophones and seismometers	Indirect measurement	N/A	Monitor CO_2 plume migration and reservoir integrity

Table 2. Instrumentation Summary

Monitoring Location	Instrument Type	Monitoring Target (Formation or Other)	Data Collection Location(s)	Explanation
CO_2 Facility	Pressure / Temperature gauge	Injection	Plant, after compression	Monitor the operational, equipment and permit parameters
	Flowmeter	Injection	Plant, after compression	Monitor the operational, equipment and permit parameters
Injection Well Mendota_ INJ_1	Pressure / Temperature gauge	Injection	Wellhead	Monitor the operational, equipment and permit parameters
	Pressure / Temperature gauge	Injection well annular pressure	Wellhead	Monitor the operational, equipment and permit parameters; well integrity of casing, tubing and packer
	Fluid level	Injection well annular fluid level	Wellhead	Monitor the operational, equipment and permit parameters; well integrity of casing, tubing and packer
	Pressure / Temperature gauge	Second Panoche sand	1 point location, below injection packer	Monitor the operational, equipment and permit parameters
	DAS fiber Ooptic acoustic & temperature	All strata	Distributed temperature / acoustic to injection packer (~9306 ft)	Monitor the operational, equipment and permit parameters; well integrity
Monitoring Well Mendota_ OBS_1	Pressure / Temperature gauge	Second Panoche sand	1 point location, below packer	Monitor the operational parameters and plume migration
	DAS Fiber Optic Acoustic & Temperature	All strata	Distributed temperature / acoustic to packer (~10,000 ft)	Monitor the operational, equipment and permit parameters; well integrity

Monitoring Location	Instrument Type	Monitoring Target (Formation or Other)	Data Collection Location(s)	Explanation
Monitoring Well Mendota_ ACZ_1	DAS Fiber Optic Acoustic & Temperature	All strata	Distributed temperature / acoustic to packer (~8,000 ft)	Monitor the operational, equipment and permit parameters; well integrity
	Pressure / Temperature gauge	Garzas or first permeable sand above Moreno main seal	1 point location, below packer	Monitor the operational, equipment and permit parameters; seal and well integrity

Table 3. Geophysical surveys summary.

Monitoring Activity	Monitoring Location	Tool or Survey Description	Monitoring Target (Formation or Other)	Explanation
Well Log	Mendota_INJ 1	Pulsed Neutron	Logged interval TD or below the Panoche injection interval to surface casing ~1600 ft	Well integrity
	Mendota_OBS_1	Pulsed Neutron	Logged interval TD or below the Panoche injection interval to surface casing ~1600 ft	Well integrity and plume migration
	Mendota_ACZ_1	Pulsed Neutron	Logged interval TD (Garzas sand) to surface casing ~1600 ft	Well and seal integrity
	Mendota_INJ_1	Cement Bond Log / Ultrasonic casing-cement inspection log	All casing strings	Well integrity
	Mendota_OBS_1	Cement Bond Log / Ultrasonic casing-cement inspection log	All casing strings	Well integrity
	Mendota_ACZ_1	Cement Bond Log / Ultrasonic casing-cement inspection log	All casing strings	Well integrity
Annulus Pressure Test	Mendota_INJ_1	Pressure Test	Tubing / Casing annular space	Well integrity
Falloff Test	Mendota_INJ_1	Pressure Fall Off Test	Injection interval	Well integrity, injection characterization
3D surface, or combination of borehole and surface seismic	Various	Seismic	Plume	Monitor plume migration

A.3.c. Geographic Locations

The injector well, Mendota_INJ 1, is located at Clean Energy Systems' Carbon Negative Energy plant near Mendota for the projects pre-construction phase. The final placement of Mendota_INJ 1, and the observation and monitoring wells are expected to be relocated as the project develops (Figure 1). The planned observation and monitoring wells are:

- Mendota_OBS_1: Monitoring the Second Panoche injection zone,
- Mendota_ACZ_1: Monitoring the first permeable formation above the Moreno, currently identified as the Garzas formation,
- Mendota_USDW_1: Monitoring well in the deepest USDW.
- Mendota_GW1-4: Nested shallow groundwater monitoring wells used to monitor the shallow aquifers around the site. The depth of these groundwater monitoring wells will be determined when the groundwater characteristics of the site are better understood. These wells are expected to be shallow in the range of 50 feet to 500 feet in depth.

Additional information on the well location selection criteria can be found in section 2 of (Schlumberger, 2021c).

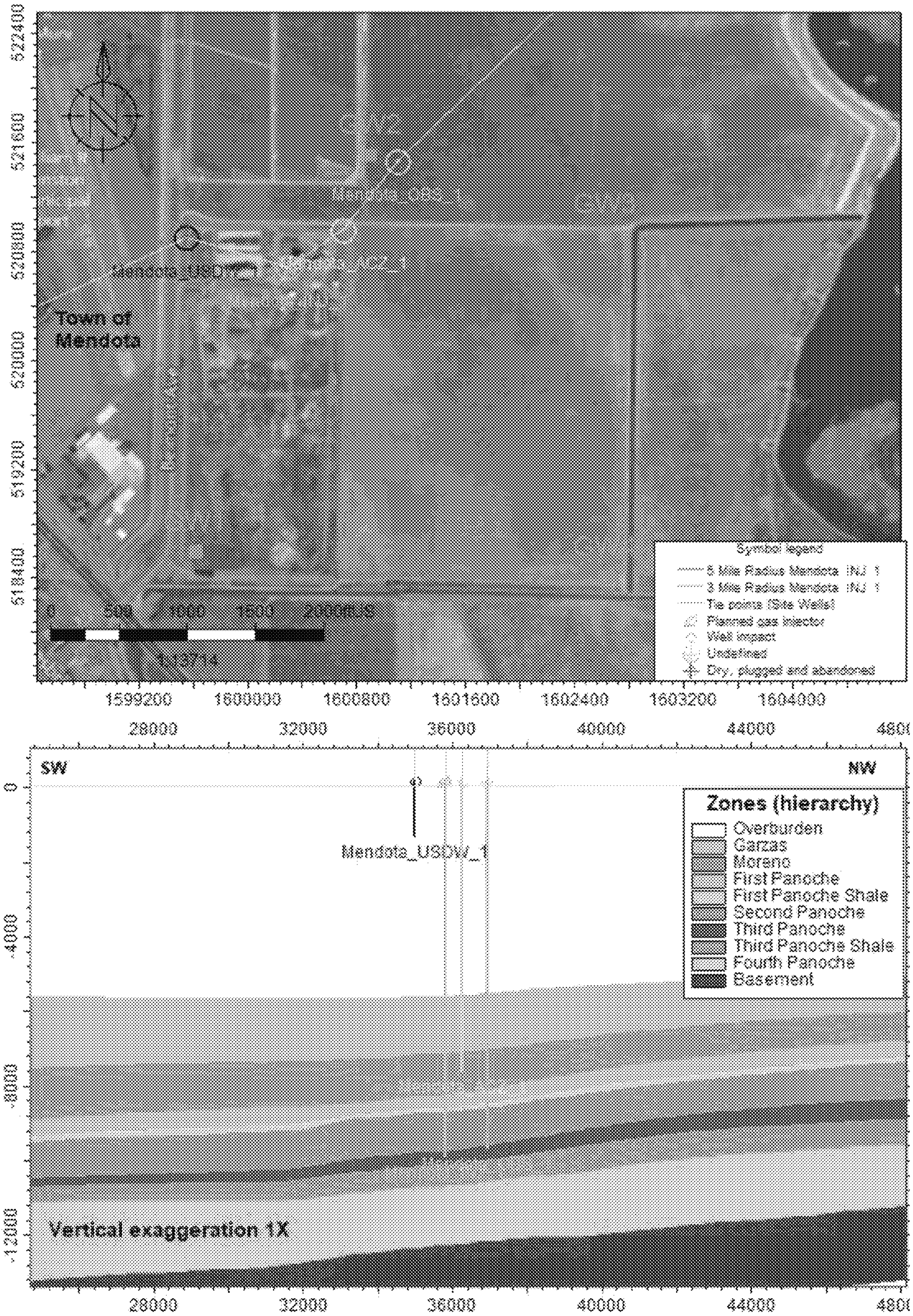


Figure 2. Clean Energy Systems Mendota site location with proposed well locations in map view and cross section view.

A.3.d. Resource and Time Constraints

No resource or time constraints have been identified during the pre-construction phase.

A.4.Quality Objectives and Criteria

A.4.a. Performance/Measurement Criteria

The overall QA objective for monitoring is to develop and implement procedures for subsurface monitoring, field sampling, laboratory analysis, and reporting which will provide results that will meet the characterization and non-endangerment goals of this project. Groundwater monitoring will be conducted during the pre-injection, injection, and post-injection phases of the project. Shallow and deep groundwater monitoring wells will be used to gather water-quality samples and pressure data. All the groundwater analytical and field monitoring parameters are listed in Table 4 and Table 5. Table 6, Table 7 and Table 8 show analytical parameters for CO_2 stream gas monitoring, corrosion coupon assessment, and gauge specifications. Table 9 shows the monitoring outputs. The list of analytes may be reassessed periodically and adjusted to include or exclude analytes based on their effectiveness to the overall monitoring program goals.

Key testing and monitoring areas include:

I. Shallow Groundwater Sampling
- Aqueous chemical concentrations

II. Deep Formation Fluid Sampling
- Aqueous chemical concentrations

III. Well Logging
- Pulsed neutron

IV. Mechanical Integrity Testing (MIT)
- Pressure, temperature and acoustic fiber (DAS)
- Pulsed neutron
- Cement and casing evaluation logs

V. Pressure/Temperature Monitoring
- Pressure/temperature from in-situ gauges
- Pressure/temperature from surface gauges

VI. CO_2 Stream Analysis
- CO_2 Purity (% v/v, [GC])
- Oxygen (O_2, ppm v/v)
- Nitrogen (N_2, ppm v/v)
- Carbon Monoxide (CO, ppm v/v)
- Oxides of Nitrogen (NOx, ppm v/v)
- Ammonia (NH_3, ppm v/v)
- Hydrogen Sulfide (H_2S ppm v/v)
- Argon (Ar ppm v/v)
- Hydrogen (H_2 ppm v/v)
- isotope δ13C (per mil, ‰)

VII. Geophysical Monitoring
- Time-lapse plume monitoring processed report

Table 4. Summary of Analytical and Field Parameters for Fluid Samples in Santa Margarita or Quaternary Groundwater samples.

Parameters	Analytical Methods (1)	Detection Limit/Range	Typical Precisions	QC Requirements
Cations: Al, Ba, Mn, As, Cd, Cr, Cu, Pb, Sb Se, Zn, and Tl	ICP-MS or ICP-OES ASTM D5673, EPA 200.8	0.001 to 0.1 mg/L (analyte, dilution and matrix dependent)	±15%	Daily calibration; blanks, duplicates, QC check std, and matrix spikes at 10% or greater frequency
Cations: Ca, Fe, K, Mg, Na, and Si	Ion Chromatography, EPA Method 200.8 ASTM 6919	0.005 to 0.5 mg/L (analyte, dilution and matrix dependent)	±15%	Daily calibration; blanks, duplicates, QC check std, and matrix spikes at 10% or greater frequency
Anions: Br, Cl, F, NO3, and SO4	Ion Chromatography, EPA Method 300.1 ASTM 4327	0.005 to 0.5 mg/L (analyte, dilution and matrix dependent)	±15%	Daily calibration; blanks, duplicates, QC check std, and matrix spikes at 10% or greater frequency
Dissolved Gases: CO2	Coulometric titration, ASTM D513-11	25 mg/L	±15%	Duplicate measurement; standards at 10% or greater frequency

Total dissolved solids	ASTM D5907-10 EPA 160.1	12 mg/L	±10%	Balance calibration, duplicate analysis, QC check std
Alkalinity	EPA 310.1	0.1 mg/L	±10%	Daily calibration of pH, blanks, duplicates, QC check std
pH (field)	EPA Method 150.1	2 to 12 pH units	±0.1 pH unit	User calibration per manufacturer recommendation, QC check std
Specific conductance (field)	EPA 120.1 ASTM 1125	0 to 200 mS/cm	±1% of reading	User calibration per manufacturer recommendation, QC check std
Temperature (field)	Thermocouple	-5 to 50°C	±0.2°C	Factory calibration
Hardness	ASTM D1126	2 to 5 mg/L CaCO3	2 mg/L	Blank, duplicate, QC check std
Turbidity	EPA 180.1	0 NTU	Scale Dependent 0.1-1 NTU	Blank, duplicate, QC check std
Specific Gravity	Modified ASTM 4052	N/A	±0.001	User calibration per manufacturer recommendation, QC check std, Air check std

Water Density	Modified ASTM 4052	N/A	±0.001 g/cc	User calibration per manufacturer recommendation, QC check std, Air check std

Note 1: An equivalent method may be employed with the prior approval of the UIC Program Director.

Table 5. Summary of Analytical and Field Parameters for Fluid Samples in Garzas or first permeable sand above Moreno main seal (Mendota_ACZ_1) and Panoche sands (Mendota_OBS_1).

Parameters	Analytical Methods (1)	Detection Limit/Range	Typical Precisions	QC Requirements
Cations: Al, Ba, Mn, As, Cd, Cr, Cu, Pb, Sb Se, Zn, and Tl	ICP-MS or ICP-OES ASTM D5673, EPA 200.8	0.001 to 0.1 mg/L (analyte, dilution and matrix dependent)	±15%	Daily calibration; blanks, duplicates, QC check std, and matrix spikes at 10% or greater frequency
Cations: Ca, Fe, K, Mg, Na, and Si	Ion Chromatography, EPA Method 200.8 ASTM 6919	0.005 to 0.5 mg/L (analyte, dilution and matrix dependent)	±15%	Daily calibration; blanks, duplicates, QC check std, and matrix spikes at 10% or greater frequency
Anions: Br, Cl, F, NO3, and SO4	Ion Chromatography, EPA Method 300.1 ASTM 4327	0.005 to 0.5 mg/L (analyte, dilution and matrix dependent)	±15%	Daily calibration; blanks, duplicates, QC check std, and matrix spikes at 10% or greater frequency
Dissolved Gases: CO2	Coulometric titration, ASTM D513-11	25 mg/L	±15%	Duplicate measurement; standards at 10% or greater frequency

Total dissolved solids	ASTM D5907-10 EPA 160.1	12 mg/L	±10%	Balance calibration, duplicate analysis, QC check std
Alkalinity	EPA 310.1	0.1 mg/L	±10%	Daily Calibration of pH, blanks, duplicates, QC check std
pH (field)	EPA Method 150.1	2 to 12 pH units	±0.1 pH unit	User calibration per manufacturer recommendation, QC check std
Specific conductance (field)	EPA 120.1 ASTM 1125	0 to 200 mS/cm	±1% of reading	User calibration per manufacturer recommendation, QC check std
Temperature (field)	Thermocouple	-5 to 50°C	±0.2°C	Factory calibration
Hardness	ASTM D1126	2 to 5 mg/L $CaCO_3$	2 mg/L	Blank, duplicate, QC check std
Turbidity	EPA 180.1	0 NTU	Scale Dependent 0.1-1 NTU	Blank, duplicate, QC check std
Specific Gravity	Modified ASTM 4052	N/A	±0.001	User calibration per manufacturer recommendation, QC check std, Air check std

Water Density	Modified ASTM 4052	N/A	±0.001 g/cc	User calibration per manufacturer recommendation, QC check std, Air check std

Note 1: An equivalent method may be employed with the prior approval of the UIC Program Director.

Table 6. Summary of Analytical Parameters for CO_2 Stream.

Parameters	Analytical Methods[a]	Detection Limit/Range	Typical Precisions	QC Requirements
Oxygen	ISBT 4.0 (GC/DID)	1 uL/L to 5,000 uL/L (ppm by volume)	± 10 % of reading	daily standard within 10 % of calibration, secondary standard after calibration
	GC/TCD	0.1 % to 100 %	5 - 10 % relative across the range, RT ± 0.1 min	daily standard, duplicate analysis within 10 % of each other
Nitrogen	ISBT 4.0 (GC/DID)	1 uL/L to 5,000 uL/L (ppm by volume)	± 10 % of reading	daily standard within 10 % of calibration, secondary standard after calibration
	GC/TCD	0.1 % to 100 %	5 - 10 % relative across the range, RT ± 0.1 min	daily standard, duplicate analysis within 10 % of each other
Argon	ISBT 4.0 (GC/DID)			
	GC/TCD			
Hydrogen	ISBT 4.0 (GC/DID)			
	GC/TCD			
Carbon monoxide	ISBT 5.0 Colorimetric	5 uL/L to 100 uL/L (ppm by volume)	± 20 % of reading	duplicate analysis
	ISBT 4.0 (GC/DID)	1 uL/L to 5,000 uL/L (ppm by volume)	± 10 % of reading	daily standard within 10 % of calibration,secondary standard after calibration
Oxides of nitrogen	ISBT 7.0 Colorimetric	0.2 uL/L to 5 uL/L (ppm by volume)	± 20 % of reading	duplicate analysis
Ammonia	ISBT 6.0 (DT)	0.5 uL/L to 2.5 uL/L (ppm by volume)	± 10 % of reading	User calibration per manufacturer recommendation
Hydrogen sulfide	ISBT 14.0 (GC/SCD	0.01 uL/L to 50 uL/L (ppm by volume)-dilution dependen	5 - 10 % of reading relative across the range	daily blank, daily standard within 10 % of calibration, secondary standard after calibration
CO_2 purity	ISBT 2.0 Caustic absorption Zahm-Nagel	99.00% to 99.99%	± 10 % of reading	User calibration per manufacturer recommendation
	ALI method SAM 4.1 subtraction method (GC/DID)	1 ppm for each target analyte (analyte dependent) - refer to Oxygen and Nitrogen analysis.	5-10 % relative across the range	duplicate analysis within 10 % of each other

	GC/TCD	0.1 % to 100 %	5-10 % relative across the range, RT ± 0.1 min	standard with every sample, duplicate analysis within 10 % of each other
[a] An equivalent method may be employed with the prior approval of the UIC Program Director.				

Table 7. Summary of Analytical Parameters for Corrosion Coupons.

Parameters	Analytical Methods	Detection Limit/Range	Typical Precisions	QC Requirements
Mass	NACE RP0775-2005	.005mg	+/-2%	Annual Calibration of Scale
Thickness	NACE RP0775-2005	.001mm	+/-005mm	Factory calibration

Table 8. Summary of Measurement Parameters for Field Gauges.

Parameters	Methods	Detection Limit/Range	Typical Precisions	QC Requirements
Booster pump discharge pressure	ANSI Z540-1-1994	+/- 0.001 psi / 0-3000 psi	+/- 0.01 psi	Annual Calibration of Scale
Injection tubing temperature	ANSI Z540-1-1994	+/- 0.001 F / 0-500 F	+/- 0.01 F	Annual Calibration of Scale
Annulus pressure	ANSI Z540-1-1994	+/- 0.001 psi / 0-3000 psi	+/- 0.01 psi	Annual Calibration of Scale
Injection tubing pressure	ANSI Z540-1-1994	+/- 0.001 psi / 0-3000 psi	+/- 0.01 psi	Annual Calibration of Scale
Wellhead pressure	ANSI Z540-1-1994	+/- 0.001 psi / 0-3000 psi	+/- 0.01 psi	Annual Calibration of Scale
Downhole temperature	ANSI Z540-1-1994	+/- 0.001 F / 0-500 F	+/- 0.01 F	Annual Calibration of Scale
Injection mass flow rate	Unknown		+/- 0.01 lb/hr	

Table 9. Actionable Testing and Monitoring Outputs.

Activity or Parameter	Project Action Limit	Detection Limit	Anticipated Reading
Mechanical integrity (Distributed Acoustic Sensing (DAS) – Temperature and Acoustic fiber)	Action taken when there is anomaly in the temperature profile or a detected seismic event greater than M3.5 within 8 miles of the injection well.		No seismic event greater than M3.5 within 8 miles of the injection well.
Mechanical integrity (Pulsed Neutron Log)	Action taken when pulsed neutron measurements indicate CO_2 outside of expected range / zone	Tool and logging speed dependent Typical Pulsar: SIGM +/- 0.5 cu TPHI +/- 0.9 pu FNXS +/- 0.15 1/m	No measurement change from baseline caused by CO_2 in annular space above injection zone or in formation above confining zone
Surface pressure / temperature	Action will be taken when pressures are well outside of modeled / expected range.		
Downhole pressure / temperature	Action will be taken when pressures are well outside of modeled/expected range.		
Water quality (Garzas (ACZ), USDW or groundwater)	Action will be taken when changes in fluid constituent concentrations indicate movement of CO_2 or brines into or above the confining zone		A statistically significant difference between observed and baseline hydrochemical/physical parameter patterns
Above-confining-zone pressure (Garzas)	Action will be taken when pressures are well outside of modeled/expected range.		
Injection well annular volume	Action will be taken when annular volume is outside of expected range.		No expected annular volume change not related to temperature
3D surface seismic survey, or combination surface and well VSP	Action will be taken when CO_2 detected outside the AoR	Dependent on fluid saturation, and formation velocities	CO_2 plume migration similar to modeled

A.4.b. Precision

For groundwater sampling, data accuracy will be assessed by the collection and analysis of field blanks to test sampling procedures and matrix spikes to test laboratory procedures. Field blanks will be taken no less than one per sampling event to spot check for sample bottle contamination. Laboratory assessment of analytical precision will be the responsibility of the individual laboratories per their standard operating procedures.

Table 10 summarizes the specifications of each monitoring method. For direct pressure and logging measurements, precision data is presented in Table 11.

A.4.c. Bias

Laboratory assessment of analytical bias will be the responsibility of the individual laboratories per their standard operating procedures and analytical methodologies. For direct pressure or logging measurements, there is no bias.

A.4.d. Representativeness

For groundwater sampling, data representativeness expresses the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. The sampling network has been designed to provide data representative of site conditions. For analytical results of individual groundwater samples, representativeness will be estimated by ion and mass balances. Ion balances with ±10% error or less will be considered valid. Mass balance assessment will be used in cases where the ion balance is greater than ±10% to help determine the source of error. For a sample and its duplicate, if the relative percent difference is greater than 10%, the sample may be considered non-representative.

A.4.e. Completeness

For groundwater sampling, data completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. It is anticipated that data completeness of 90% for groundwater sampling will be acceptable to meet monitoring goals. For direct pressure and temperature measurements, it is expected that data will be recorded no less than 90% of the time.

A.4.f. Comparability

Data comparability expresses the confidence with which one data set can be compared to another. The data sets to be generated by this project will be very comparable to future data sets because of the use of standard methods and the level of QA/QC effort. If historical groundwater quality data become available from other sources, their applicability to the project and level of quality will be assessed prior to use with data gathered on this project. Direct pressure, temperature, and logging measurements will be directly comparable to previously obtained data.

A.4.g. Method Sensitivity

Table 12 through Table 15 provide additional details on gauge specifications and sensitivities.

Table 10. Pressure and Temperature—Downhole Gauge Specifications.

Parameter	Value
Calibrated working pressure range	Atmospheric to 10,000 psi
Initial pressure accuracy	<+/-2 psi over full scale
Pressure resolution	0.005 psi at 1-s sample rate
Pressure drift stability	<+/-1 psi per year over full scale
Calibrated working temperature range	77–266°F
Initial temperature accuracy	<+/-0.9°F per +/-0.27°F
Temperature resolution	0.009°F at 1-s sample rate
Temperature drift stability	<+/-0.1°F per year at 302°F
Max temperature	302°F
Instrument calibration frequency	

Table 11. Representative Logging Tool Specifications.

Parameter	Pulsar (Pulsed Neutron)	CBL – Cement Bond Log	PowerFlex (Ultrasonic casing / cement inspection)
Logging speed	Up to 3,600 ft/hr	Up to 3,600 ft/hr	400 to 4,500 ft/hr
Vertical resolution	15 in	3 ft	0.6 to 6.0 in
Investigation	Formation fluid saturation, annular space	Cement Bond (Cement-Casing, Cement-formation)	Casing and Cement (Cement-Casing, Cement-formation and annular coverage)
Temperature rating	350 degF	350 degF	350 degF
Pressure rating	15,000 psi	20,000 psi	20,000 psi

Table 12. Pressure Field Gauge—Injection Tubing Pressure.

Parameter	Value
Calibrated working pressure range	0 to 3000 psi
Initial pressure accuracy	< 0.04375%
Pressure resolution	0.001 psi

Parameter	Value
Pressure drift stability	

Table 13. Pressure Field Gauge — Injection Annulus Pressure.

Parameter	Value
Calibrated working pressure range	0 to 3000 psi
Initial pressure accuracy	< 0.04375%
Pressure resolution	0.001 psi
Pressure drift stability	

Table 14. Temperature Field Gauge—Injection Tubing Temperature.

Parameter	Value
Calibrated working temperature range	0 to 500°F
Initial temperature accuracy	< 0.0055 %
Temperature resolution	0.001°F
Temperature drift stability	

Table 15. Mass Flow Rate Field Gauge— CO_2 Mass Flow Rate.

Parameter	Value
Calibrated working flow rate range	50,522 to 303,133 lb/hr
Initial mass flow rate accuracy	< 0.18%
Mass flow rate resolution	0.0001 lb/hr
Mass flow rate drift stability	

A.5. Special Training/Certifications

A.5.a. Specialized Training and Certifications

The geophysical survey equipment and wireline logging tools will be operated by trained, qualified, and certified personnel, according to the service company that provides the equipment. The subsequent data will be processed and analyzed according to industry standards. No specialized certifications are required for personnel conducting groundwater sampling, but field sampling will be conducted by trained personnel. Groundwater sampling will be conducted by personnel trained to understand and follow the project specific sampling procedures. Upon request, CES will provide the agency with all laboratory SOPs developed for the specific parameter using the appropriate standard method. Each laboratory technician conducting the analysis on the samples will be trained on the SOP developed for each standard method. CES will include the technician's training certification with the annual report.

A.5.b/c. Training Provider and Responsibility

Training for personnel will be provided by the operator or by the subcontractor responsible for the data collection activity.

A.6. Documentation and Records

A.6.a. Report Format and Package Information

An annual report from CES to USEPA will contain all required project data, including testing and monitoring information as specified by the UIC Class VI permit. Data will be provided in electronic or other formats as required by the UIC Program Director.

A.6.b. Other Project Documents, Records, and Electronic Files

Other documents, records, and electronic files such as well logs, test results, or other data will be provided as required by the UIC Program Director.

A.6.c/d. Data Storage and Duration

CES or a designated contractor will maintain the required project data as provided elsewhere in the permit.

A.6.e. QASP Distribution Responsibility

The CES - CNE plant manager will be responsible for ensuring that all those on the distribution list will receive the most current copy of the approved Quality Assurance and Surveillance Plan.

B. Data Generation and Acquisition

B.1. Sampling Process Design

Discussion in this section is focused on groundwater and fluid sampling and does not address monitoring methods that do not gather physical samples (e.g., logging, seismic monitoring, and pressure/temperature monitoring). During the pre-injection and injection phases, groundwater sampling is planned to include an extensive set of chemical parameters to establish aqueous geochemical reference data. Parameters will include selected constituents that: (1) have primary and secondary USEPA drinking water maximum contaminant levels, (2) are the most responsive to interaction with CO_2 or brine, (3) are needed for quality control, and (4) may be needed for geochemical modeling. The full set of parameters for each sampling interval is given in Table 4 and Table 5. After a sufficient baseline is established, monitoring scope may shift to a subset of indicator parameters that are (1) the most responsive to interaction with CO_2 or brine and (2) are needed for quality control. Implementation of a reduced set of parameters would be done in consultation with the

USEPA. Isotopic analyses will be performed on baseline samples to the degree that the information helps verify a condition or establish an understanding of non-project related variations. For non-baseline samples, isotopic analyses may be reduced in all monitoring wells if a review of the historical project results or other data determines that further sampling for isotopes is unneeded. During any period where a reduced set of analytes is used, if statistically significant trends are observed that are the result of unintended CO_2 or brine migration, the analytical list would be expanded to the full set of monitoring parameters. The groundwater samples will be analyzed using a laboratory meeting the requirements under the USEPA Environmental Laboratory Accreditation Program. All other samples will be analyzed by the operator or a third party laboratory. Dissolved CO_2 will be analyzed by methods consistent with Test Method B of ASTM D 513-16, "Standard Test Methods for Total and Dissolved Carbon Dioxide in Water" or equivalent. Isotopic analysis will be conducted using established methods.

B.1.a. Design Strategy

CO_2 Stream Monitoring Strategy

The primary purpose of analyzing the carbon dioxide stream is to evaluate the potential interactions of carbon dioxide and/or other constituents of the injectate with formation solids and fluids. This analysis can also identify (or rule out) potential interactions with well materials. Establishing the chemical composition of the injectate also supports the determination of whether the injectate meets the qualifications of hazardous waste under the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. 6901 et seq. (1976), and/or the Comprehensive Environmental Response, Compensation, and Liability Act, (CERCLA) 42 U.S.C. 9601 et seq. (1980). Additionally, monitoring the chemical and physical characteristics of the carbon dioxide (e.g., isotopic signature, other constituents) may help distinguish the injectate from the native fluids and gases if unintended leakage from the storage reservoir occurred. Injectate monitoring is required at a sufficient frequency to detect changes to any physical and chemical properties that may result in a deviation from the permitted specifications.

Calibration of transmitters used to monitor pressures, temperatures, and flow rates of CO_2 into the injection well shall be conducted annually. Reports shall contain test equipment used to calibrate the transmitters, including test equipment manufacturers, model numbers, serial numbers, calibration dates and expiration dates.

Corrosion Monitoring Strategy

Corrosion coupon analyses will be conducted quarterly to aid in ensuring the mechanical integrity of the equipment in contact with the carbon dioxide. Coupons shall be sent quarterly to a qualified company for analysis and an analysis conducted in accordance with NACE Standard RP-0775 (or similar) to determine and document corrosion wear rates based on mass loss.

Shallow Groundwater Monitoring Strategy

Four dedicated monitoring wells are planned for shallow groundwater monitoring. These wells will be installed and screened in the Quaternary-age deposits to depths of 50 to 500 ft below ground surface (bgs) to cover permeable zones containing water supplies. The local Quaternary-age deposits are used predominantly as irrigation and ground water monitoring wells. The groundwater monitoring wells are designated as Mendota_GW-1, Mendota_GW-2, Mendota_GW-3, and Mendota_GW-4 (Figure 2). The wells will be selected to give a spatial distribution around the planned CO_2 injection well (Mendota_INJ_1) location.

The ground water monitoring wells Mendota GW 1, Mendota GW 2, Mendota GW 3, and Mendota GW 4 will be used for fluid sampling of the Quaternary-age deposits at prescribed frequencies in Attachment C: Testing and Monitoring Plan 40 CFR 146.90 Clean Energy Systems Mendota (Schlumberger, 2021c) Table 6 and in consultation with USEPA and California Natural Resources Agency. Fluid sampling will occur using a portable swabbing rig or other available sampling technologies. Samples will be analyzed for constituents listed in Table 4 to document baseline fluid chemistry and to detect changes in fluid chemistry that could result from the movement of brine or CO_2 from the storage interval through the seal formation.

Deep Groundwater Monitoring Strategy

Monitoring of the deeper USDW is expected to be in the Santa Margarita around 1615 ft bgs. The deepest USDW will be confirmed with the characterization well. Fluid sampling of the USDW is planned in Mendota_USDW_1 (Figure 2) and additionally monitored with temperature monitoring and pulse neutron logging to determine if any CO_2 or salt water leakage occurs into the USDW.

The USDW monitoring well, Mendota_USDW_1will be used for fluid sampling of the Santa Margarita or deepest USDW formation at prescribed frequencies in (Schlumberger, 2021c) Table 6 and in consultation with USEPA and California Natural Resources Agency. Fluid sampling will occur using a portable swabbing rig or other available sampling technologies. Samples will be analyzed for constituents listed in Table 4 to document baseline fluid chemistry and to detect changes in fluid chemistry that could result from the movement of brine or CO_2 from the storage interval through the seal formation.

B.1.b. Type and Number of Samples/Test Runs

Groundwater and USDW sampling frequencies are detailed in Attachment C: Testing and Monitoring 40 CFR 146.90 Clean Energy Systems Mendota (Schlumberger, 2021c) Table 6. CO_2 gas stream and corrosion coupon sampling (Table 1) frequencies are detailed in the same document (Schlumberger, 2021c), section 5.1.

B.1.c. Site/Sampling Locations

Shallow groundwater monitoring will use wells Mendota_GW_1, Mendota_GW _2, Mendota_GW_3, and Mendota_GW _4, as noted in Section B.1.a. Deep groundwater monitoring will use well Mendota_USDW_1 also noted in Section B.1.a. In addition, sampling of the deepest permeable zone above the Moreno mail seal will use Mendota_ACZ_1.

CO_2 gas stream and corrosion coupon sampling locations will occur in the compressor building after the last stage of compression

B.1.d. Sampling Site Contingency

All groundwater wells are expected to be constructed on CES property and no site inaccessibility are anticipated at this time. If the final well locations are not on property exclusively owned by CES, the site contingency plan will be reassessed and revised.

B.1.e. Activity Schedule

Groundwater and USDW sampling frequencies are detailed in *(Schlumberger, 2021c)* Table 6. CO_2 gas stream and corrosion coupon sampling is detailed in *(Schlumberger, 2021c)* section 5.1.

B.1.f. Critical/Informational Data

During both groundwater sampling and analytical efforts, detailed field and laboratory documentation will be taken. Documentation will be recorded in field and laboratory forms and notebooks. Critical information will include time and date of activity, person/s performing activity, location of activity (wellfield sampling) or instrument (laboratory analysis), field or laboratory instrument calibration data, field parameter values. For laboratory analyses, much of the critical data are generated during the analysis and provided to end users in digital and printed formats. Noncritical data may include appearance and odor of the sample, problems with well or sampling equipment, and weather conditions.

B.1.g. Sources of Variability

Potential sources of variability related to monitoring activities include (1) natural variation in fluid quality, formation pressure and temperature and seismic activity; (2) variation in fluid quality, formation pressure and temperature, and seismic activity due to project operations; (3) changes in recharge due to rainfall, drought, and snowfall; (4) changes in instrument calibration during sampling or analytical activity; 5) different staff collecting or analyzing samples; (6) differences in environmental conditions during field sampling activities; (7) changes in analytical data quality during life of project; and (8) data entry errors related to maintaining project database.

Activities to eliminate, reduce, or reconcile variability related to monitoring activities include (1) collecting long-term baseline data to observe and document natural variation in monitoring parameters, (2) evaluating data in timely manner after collection to observe anomalies in data that can be addressed by being resampled or reanalyzed, (3) conducting statistical analysis of monitoring data to determine whether variability in a data set is the result of project activities or natural variation, (4) maintaining weather related data using on-site weather monitoring data or data collected near project site (such as from local airports), (5) checking instrument calibration before, during and after sampling or sample analysis, (6) thoroughly training staff, (7) conducting laboratory quality assurance checks using third party reference materials, and/or blind and/or replicate sample checks, and (8) developing a systematic review process of data that can include sample-specific data quality checks (i.e., cation/anion balance for aqueous samples).

B.2. Sampling Methods

B.2.a/b. Sampling SOPs

Groundwater samples will be collected primarily using a low-flow sampling method consistent with ASTM D6452-18 and ATSM D6771-18 (2005) or Puls and Barcelona (1996). If a flow-through cell is not used, field parameters will be measured in grab samples. Groundwater wells will be purged to ensure samples are representative of formation water quality. Static water levels in each well will be determined using an electronic water level indicator before any purging or sampling activities begin. Dedicated pumps (e.g., bladder pumps) will be installed in each monitoring well to minimize potential cross contamination between wells. Groundwater pH, temperature, specific conductance, and dissolved oxygen will be monitored in the field using portable probes and a flow-through cell consistent with standard methods (e.g., APHA, 2005) given sufficient flow rates and volumes. Field chemistry probes will be calibrated at the beginning of each sampling day according to equipment manufacturer procedures using standard reference solutions. When a flow-through cell is used, field parameters will be continuously monitored and will be considered stable when three successive measurements made three minutes apart meet the criteria listed in Table 16.

Table 16. Stabilization Criteria of Water Quality Parameters During Shallow Well Purging.

Field Parameter	Stabilization Criteria
pH	+/- 0.2 units
Temperature	+/- 1°C
Specific conductance	+/- 3% of reading in µS/cm
Dissolved oxygen	+/- 10% of reading or 0.3 mg/L whichever is greater

After field parameters have stabilized, samples will be collected. Samples requiring filtration will be filtered through 0.45-µm flow-through filter cartridges as appropriate and consistent with ASTM D6564-00. Prior to sample collection, filters will be purged with a minimum of 100 mL of well water (or more if required by the filter manufacturer). For alkalinity and total CO_2 samples, efforts will be made to minimize exposure to the atmosphere during filtration, collection in sample containers, and analysis.

For deep groundwater sampling of and Mendota_USDW_1, a wireline sampling system with a sampling device (e.g., Kuster sampler or similar) capable of collecting a sample from a discrete interval will be used.

For Mendota_ACZ_1, it is anticipated that air lifting with nitrogen will be used to draw fluid into the well for purging. A gas lift valve will be placed in the tubing string at approximately 1,200 ft below ground surface at the time of the completion. The sampler will be positioned at the same elevation as the discrete perforated interval, and a sample would be collected after sufficient purging.

B.2.c. In-situ Monitoring

In-situ monitoring of groundwater chemistry parameters is not currently planned.

B.2.d. Continuous Monitoring

Continuous monitoring of groundwater level or properties is not currently planned.

B.2.e. Sample Homogenization, Composition, Filtration

Described in section B.2.b

B.2.f. Sample Containers and Volumes

For CO_2 stream monitoring, samples will be collected in a clean sample container rated for the appropriate collection pressure.

Assay for CO_2 Quarterly Gas Analysis:

- CO_2 Purity (% v/v, [GC])
- Oxygen (O_2, ppm v/v)
- Nitrogen (N_2, ppm v/v)
- Carbon Monoxide (CO, ppm v/v)
- Oxides of Nitrogen (NOx, ppm v/v)
- Ammonia (NH_3, ppm v/v)
- Sulfur Dioxide (SO_2, ppm v/v)
- Hydrogen Sulfide (H_2S ppm v/v)

For shallow and deep groundwater samples, all sample bottles will be new. Sample bottles and bags for analytes will be used as received (ready for use) from the vendor or contract analytical laboratory for the analyte of interest. A summary of sample containers is presented in Table 18.

B.2.g. Sample Preservation

For groundwater and other aqueous samples, the preservation methods in Table 18 will be used.

No preservation is required or used for CO_2 gas stream, and additional details of sampling requirements are shown in Table 17. Corrosion coupon sampling only requires that the coupons be physically separated (e.g., sleeves, baggies) during transportation to prevent physical abrasion.

B.2.h. Cleaning/Decontamination of Sampling Equipment

Dedicated pumps (e.g., bladder pumps) will be installed in each groundwater monitoring well to minimize potential cross contamination between wells. These pumps will remain in each well throughout the project period except for maintenance. Prior to installation, the pumps will be cleaned on the outside with a non-phosphate detergent. Pumps will be rinsed a minimum of three times with deionized water and a minimum of 1 L of deionized water will be pumped through pump and sample tubing. Individual cleaned pumps and tubing will be placed in plastic garbage bags for transport to the field for installation. All field glassware (pipets, beakers, filter holders, etc.) are cleaned with tap water to remove any loose dirt, washed in a dilute nitric acid solution, and rinsed three times with deionized water before use.

B.2.i. Support Facilities

For sampling of groundwater, the following are required: air compressor, vacuum pump, generator, multi-electrode water quality sonde, analytical meters (pH, specific conductance, etc.). Field activities are usually completed in field vehicles and portable laboratory trailers located on site.

Sampling tubing, connectors, and valves required to sample the CO_2 gas stream will be supplied by the analytical laboratory providing the sampling containers. Sampling will occur within the existing CO_2 compression building.

Similarly, corrosion coupons will be removed from the CO_2 injection line within the existing CO_2 compression building.

Field gauges will be removed from the injection well and verification well utilizing existing standard industry tools and equipment. Deployment and retrieval of observation and monitoring well gauges will be done using procedures and equipment recommended by the vendor, subcontractor, or is standard per industry practice.

B.2.j. Corrective Action, Personnel, and Documentation

Field staff will be responsible for properly testing equipment and performing corrective actions on broken or malfunctioning field equipment. If corrective action cannot be taken in the field, then equipment will be returned to the manufacturer for repair or replaced. Significant corrective actions affecting analytical results will be documented in field notes.

B.3. Sample Handling and Custody

Logging, geophysical monitoring, and pressure/temperature monitoring does not apply to this section, and is omitted.

Sample holding times (Table 18) will be consistent with those described in US EPA (1974), American Public Health Association (APHA, 2005), Wood (1976), and ASTM Method D6517-00 (2005). After collection, samples will be placed in ice chests in the field and maintained thereafter at approximately 4°C until analysis. The samples will be maintained at their preservation temperature and sent to the designated laboratory within 24 hours. Analysis of the samples will be completed within the holding time listed in Table 18. As appropriate, alternative sample containers and preservation techniques approved by the UIC Program Director will be used to meet analytical requirements.

B.3.a. Maximum Hold Time/Time Before Retrieval

See Table 18.

B.3.b. Sample Transportation

See description at the beginning of Section B.3.

B.3.c. Sampling Documentation

Field notes will be collected for all groundwater samples collected. These forms will be retained and archived as reference. The sample documentation is the responsibility of groundwater sampling personnel.

An analysis authorization form shall be provided with each CO_2 gas stream sample provided for analysis.

B.3.d. Sample Identification

All sample bottles will have waterproof labels with information denoting project, sampling date, sampling location, sample identification number, sample type (freshwater or brine), analyte, volume, filtration used (if any), and preservative used (if any).

Table 17. Summary of Sample Containers, Preservation Treatments, and Holding Times for CO_2 Gas Stream Analysis

Sample	Volume/Container Material	Preservation Technique	Sample Holding time (max)
CO_2 gas stream	(2) 2L MLB Polybags (1) 75 cc Mini Cylinder	Sample Storage Cabinets	5 Business Days

Table 18. Summary of Anticipated Sample Containers, Preservation Treatments, and Holding Times for Ground Water Samples.

Target Parameters	Volume/Container Material	Preservation Technique	Sample Holding Time
Cations: Ca, Fe, K, Mg, Na, Si, Al, Ba, Mn, As, Cd, Cr, Cu, Pb, Sb Se, Zn, Tl	250 ml/HDPE	Filtered, nitric acid, cool 4°C	60 days
Anions: Br, Cl, F, NO_3, SO_4	250 ml/HDPE	Filtered, nitric acid, cool 4°C	60 days
Dissolved CO_2	60 ml/HDPE	Filtered, cool 4°C	14 days
Isotopes: $\delta^{13}C$ of DIC	60 ml/HDPE	Filtered, cool 4°C	4 weeks
Alkalinity	500 ml/HDPE	Filtered, cool 4°C	45 days
Field Confirmation: Temperature, dissolved	200 ml/glass jar	None	< 1 hour

oxygen, specific conductance, pH			
Field Confirmation Density	60 ml/HDPE	Filtered	< 1 hour

B.3.e. Sample Chain-of-Custody

For CO_2 stream analysis, an analysis authorization form will accompany the sample to the laboratory at which point a chain-of-custody accompanies the sample through their processes.

For groundwater samples, chain-of-custody will be documented using a standardized form. A typical form is shown in Appendix A, Figure 3.Copies of the form will be provided to the person/laboratory receiving the samples as well as the person/laboratory transferring the samples. These forms will be retained and archived to allow tracking of sample status. The chain-of -custody form and record keeping is the responsibility of groundwater sampling personnel.

B.4. Analytical Methods

Logging, geophysical monitoring, and pressure/temperature monitoring does not apply to this section, and is omitted.

B.4.a. Analytical SOPs

Analytical SOPs are referenced in Table 4 and Table 5. Other laboratory specific SOPs utilized by the laboratory will be determined after a contract laboratory has been selected. Upon request CES will provide the agency with all laboratory SOPs developed for the specific parameter using the appropriate standard method. Each laboratory technician conducting the analysis on the samples will be trained on the SOP developed for each standard method. CES will include the technician's training certification with the annual report.

B.4.b. Equipment/Instrumentation Needed

Equipment and instrumentation is specified in the individual analytical methods referenced in Table 4 and Table 5.

B.4.c. Method Performance Criteria

Nonstandard method performance criteria are not anticipated for this project.

B.4.d. Analytical Failure

Each laboratory conducting the analyses in Table 4 and Table 5 will be responsible for appropriately addressing analytical failure according to their individual SOPs.

B.4.e. Sample Disposal

Each laboratory conducting the analyses in in Table 4 and Table 5 will be responsible for appropriate sample disposal according to their individual SOPs.

B.4.f. Laboratory Turnaround

Laboratory turnaround will vary by laboratory, but generally turnaround of verified analytical results within one month will be suitable for project needs.

B.4.g. Method Validation for Nonstandard Methods

Nonstandard methods are not anticipated for this project. If nonstandard methods are needed or proposed in the future, the USEPA will be consulted on additional appropriate actions to be taken.

B.5. Quality Control

Geophysical monitoring and pressure/temperature monitoring does not apply to this section, and is omitted.

B.5.a. QC activities

Blanks

For shallow groundwater sampling, a field blank will be collected and analyzed for the inorganic analytes in Table 4 and Table 5 at a frequency of 10% or greater. Field blanks will be exposed to the same field and transport conditions as the groundwater samples. Blanks will also be utilized for deep groundwater sampling and analyzed for the inorganic analytes in Table 4 and Table 5 at a frequency of 10% or greater. Field blanks will be used to detect contamination resulting from the collection and transportation process.

Duplicates

For each shallow groundwater sampling round, a duplicate groundwater sample is collected from a well from a rotating schedule. Duplicate samples are collected from the same source immediately after the original sample in different sample containers and processed as all other samples. Duplicate samples are used to assess sample heterogeneity and analytical precision.

B.5.b. Exceeding Control Limits

If the sample analytical results exceed control limits (i.e., ion balances $> \pm 10\%$), further examination of the analytical results will be done by evaluating the ratio of the measured total dissolved solids (TDS) to the calculated TDS (i.e., mass balance) per APHA method. The method indicates which ion analyses should be considered suspect based on the mass balance ratio. Suspect ion analyses are then reviewed in the context of historical data and interlaboratory results, if available. Suspect ion analyses are then brought to the attention of the analytical laboratory for confirmation and/or reanalysis. The ion balance is recalculated, and if the error is still not resolved, suspect data are identified and may be given less importance in data interpretations.

B.5.c. Calculating Applicable QC Statistics

Charge Balance

The analytical results are evaluated to determine correctness of analyses based on anion-cation charge balance calculation. Because all potable waters are electrically neutral, the chemical analyses should yield equally negative and positive ionic activity. The anion-cation charge balance will be calculated using the formula:

Equation 1

$$\%\ difference = 100\ \frac{\sum cations - \sum anions}{\sum cations + \sum anions}$$

where the sums of the ions are represented in milliequivalents (meq) per liter and the criteria for acceptable charge balance is ±10%.

Mass Balance

The ratio of the measured TDS to the calculated TDS will be calculated in instances where the charge balance acceptance criteria are exceeded using the formula:

Equation 2

$$1.0 < \frac{measured\ TDS}{calculated\ TDS} < 1.2,$$

where the anticipated values are between 1.0 and 1.2.

Outliers

A determination of one or more statistical outliers is essential prior to the statistical evaluation of groundwater. This project will use the USEPA's Unified Guidance (March 2009) guidance as a basis for selection of recommended statistical methods to identify outliers in groundwater chemistry data sets as appropriate. These techniques include Probability Plots, Box Plots, Dixon's test, and Rosner's test. The EPA-1989 outlier test may also be used as another screening tool to identify potential outliers.

B.6. Instrument/Equipment Testing, Inspection, and Maintenance

Logging tool equipment will be maintained as per wireline industry best practices.

For groundwater sampling, field equipment will be maintained, factory serviced, and factory calibrated per manufacturer's recommendations. Spare parts that may be needed during sampling will be included in supplies on-hand during field sampling.

For all laboratory equipment, testing, inspection and maintenance will be the responsibility of the analytical laboratory per standard practice, method-specific protocol, or NELAP requirement.

B.7. Instrument/Equipment Calibration and Frequency

Geophysical monitoring does not apply to this section, and is omitted.

B.7.a. Calibration and Frequency of Calibration

Pressure/temperature gauge calibration information is located in Table 10 - Table 15. Logging tool calibration will be at the discretion of the service company providing the equipment, following standard industry practices. Calibration frequency will be determined by standard industry practices.

For groundwater sampling, portable field meters or multiprobe sondes used to determine field parameters (e.g., pH, temperature, specific conductance, dissolved oxygen) are calibrated according to manufacturer recommendations and equipment manuals (Hach, 2006) each day before sample collection begins. Recalibration is performed if any components yield atypical values or fail to stabilize during sampling.

B.7.b. Calibration Methodology

Logging tool calibration methodology will follow standard industry practices.

For groundwater sampling, standards used for calibration are typically 7 and 10 for pH, a potassium chloride solution yielding a value of 1413 microseimens per centimeter (µS/cm) at 25°C for specific conductance, and a 100% dissolved O2 solution for dissolved oxygen. Calibration is performed for the pH meters per manufacturer's specifications using a 2-point calibration bounding the range of the sample. For coulometry, sodium carbonate standards (typically yielding a concentration of 4,000 mg CO_2/L) are routinely analyzed to evaluate instrument.

B.7.c. Calibration Resolution and Documentation

Logging tool calibration resolution and documentation will follow standard industry practices.

For groundwater sampling, calibration values are recorded in daily sampling records and any errors in calibration are noted. For parameters where calibration is not acceptable, redundant equipment may be used so loss of data is minimized.

B.8. Inspection/Acceptance for Supplies and Consumables

B.8.a/b. Supplies, Consumables, and Responsibilities

Supplies and consumables for field and laboratory operations will be procured, inspected, and accepted as required from vendors approved by CES or the respective subcontractor responsible for the data collection activity. Acquisition of supplies and consumables related to groundwater analyses will be the responsibility of the laboratory per established standard methodology or operating procedures.

B.9. Nondirect Measurements

B.9.a. Data Sources

For time-lapse seismic surveys, repeatability is paramount for accurate differential comparison. Therefore, to ensure survey quality, the locations for the shots and acquisition methodology of sequential surveys will be consistent. Once these surveys are conducted, they will be compared to a baseline survey to track and monitor plume development.

For in-zone pressure monitoring, the in-zone pressure gauges in Mendota_OBS_1_1 will be used to gather pressure data.

B.9.b. Relevance to Project

Time-lapse seismic surveys will be used to track changes in the CO_2 plume in the subsurface. Processing and comparing subsequent surveys to a baseline will allow project managers to monitor plume growth, as well as to ensure that the plume does not move outside of the intended storage reservoir. Numerical modeling will be used to predict the CO_2 plume growth and migration over time by combining the processed seismic data with the existing geologic model.

In-zone pressure monitoring data will be used in numerical modeling to predict plume and pressure front behavior and confirm the plume stage within the AoR.

B.9.c. Acceptance Criteria

Following standard industry practices will ensure that the gathered seismic data will be used for accurate modeling and monitoring. Similar ground conditions, shot points located within tolerable limits, functional geophones, and similar seismic input signal will be used from survey to survey to ensure repeatability.

When processing seismic data, several QA checks will be done in accordance with industry standards including reformatting to Omega structured files, geometry application, amplitude compensation, predictive deconvolution, elevation statics correction, RMS amplitude gain, velocity analysis every 2 km, NMO application using picked velocities, CMP stacking, random noise attenuation, and instantaneous gain.

B.9.d. Resources/Facilities Needed

CES will subcontract all necessary resources and facilities for the seismic monitoring, in-zone pressure monitoring, and groundwater sampling.

B.9.e. Validity Limits and Operating Conditions

For seismic surveys and numerical modeling, intraorganizational checks between trained and experienced personnel will ensure that all surveys and numerical modeling are conducted conforming to standard industry practices.

B.10. Data Management

B.10.a. Data Management Scheme

CES or a designated contractor will maintain the required project data as provided elsewhere in the permit. Data will be backed up on tape or held on secure servers.

B.10.b. Recordkeeping and Tracking Practices

All records of gathered data will be securely held and properly labeled for auditing purposes.

B.10.c. Data Handling Equipment/Procedures

All equipment used to store data will be properly maintained and operated according to proper industry techniques. All data will be held on a secure server.

B.10.d. Responsibility

The primary project managers will be responsible for ensuring proper data management is maintained.

B.10.e. Data Archival and Retrieval

All data will be held by CES. These data will be maintained and stored for auditing purposes as described in section B.10.a

B.10.f. Hardware and Software Configurations

All CES and vendor hardware and software configurations will be appropriately interfaced.

B.10.g. Checklists and Forms

Checklists and forms will be procured and generated as necessary.

C. Assessment and Oversight

C.1. Assessments and Response Actions

C.1.a. Activities to be Conducted

Please refer to Table 1. Summary of Testing and Monitoring in section A.3.a/b.; groundwater quality data will be collected at the frequency outlined in that table. After completion of sample analysis, results will be reviewed for QC criteria as noted in section B.5. If the data quality fails to meet criteria set in section B.5., samples will be reanalyzed, if still within holding time criteria. If outside of holding time criteria, additional samples may be collected or sample results may be excluded from data evaluations and interpretations. Evaluation for data consistency will be performed according to procedures described in the USEPA 2009 Unified Guidance (USEPA, 2009).

C.1.b. Responsibility for Conducting Assessments

Organizations gathering data will be responsible for conducting their internal assessments. All stop work orders will be handled internally within individual organizations.

C.1.c. Assessment Reporting

All assessment information should be reported to the individual organizations project manager outlined in A.1.a/b.

C.1.d. Corrective Action

All corrective action affecting only an individual organization's data collection responsibility should be addressed, verified, and documented by the individual project managers and communicated to the other project managers as necessary. Corrective actions affecting multiple organizations should be addressed by all members of the project leadership and communicated to other members on the distribution list for the QASP. Assessments may require integration of information from multiple monitoring sources across organizations (operational, in-zone monitoring, above-zone monitoring) to determine whether correction actions are required and/or the most cost-efficient and effective action to implement. CES will coordinate multiorganization assessments and corrective actions as warranted.

C.2. Reports to Management

C.2.a/b. QA status Reports

QA status reports should not be needed. If any testing or monitoring techniques are changed, the QASP will be reviewed and updated as appropriate in consultation with USEPA. Revised QASPs will be distributed by CES to the full distribution list at the beginning of this document.

D. Data Validation and Usability

D.1. Data Review, Verification, and Validation

D.1.a. Criteria for Accepting, Rejecting, or Qualifying Data

Groundwater quality data validation will include the review of the concentration units, sample holding times, and the review of duplicate, blank and other appropriate QA/QC results. All groundwater quality results will be entered into a database or spreadsheet with periodic data review and analysis. CES will retain copies of the laboratory analytical test results and/or reports. Analytical results will be reported on a frequency based on the approved UIC permit conditions. In the periodic reports, data will be presented in graphical and tabular formats as appropriate to characterize general groundwater quality and identify intrawell variability with time. After sufficient data have been collected, additional methods, such as those described in the USEPA 2009 Unified Guidance (USEPA, 2009), will be used to evaluate intrawell variations for groundwater constituents, to evaluate if significant changes have occurred that could be the result of CO_2 or brine seepage beyond the intended storage reservoir.

D.2. Verification and Validation Methods

D.2.a. Data Verification and Validation Processes

See sections D.1.a. and B.5.

Appropriate statistical software will be used to determine data consistency.

D.2.b. Data Verification and Validation Responsibility

CES or its designated subcontractor will verify and validate groundwater sampling data.

D.2.c. Issue Resolution Process and Responsibility

CES or its designated Coordinator will overview the groundwater data handling, management, and assessment process. Staff involved in these processes will consult with the Coordinator to determine actions required to resolve issues.

D.2.d. Checklist, Forms, and Calculations

Checklists and forms will be developed specifically to meet permit requirements.

D.3. Reconciliation with User Requirements

D.3.a. Evaluation of Data Uncertainty

Statistical software will be used to determine groundwater data consistency using methods consistent with USEPA 2009 Unified Guidance (USEPA, 2009).

D.3.b. Data Limitations Reporting

The organization-level project managers will be responsible for ensuring that data developed by their respective organizations is presented with the appropriate data-use limitations.

References

Schlumberger, Attachment A: Summary of Requirements Class VI Operating. (2021). *Attachment A: Summary of Requirements Class VI Operating and Reporting Conditions.*

Schlumberger, Attachment B: Area of Review and Corrective Action Plan. (2021). *Attachment B: Area of Review and Corrective Action Plan 40 CFR 146.84(b) Clean Energy Systems Mendota.*

Schlumberger, Attachment C: Testing and Monitoring Plan. (2021). *Attachment C: Testing and Monitoring Plan 40 CFR 146.90 Clean Energy Systems Mendota.*

Schlumberger, Attachment D: Injection Well Plugging Plan. (2021). *Attachment D: Injection Well Plugging Plan 40 CFR 146.92(B) Clean Energy Systems Mendota.*

Schlumberger, Attachment E: Post-Injection Site Care and Site Closure Plan. (2021). *Attachment E: Post-Injection Site Care and Site Closure Plan 40 CFR 146.93(A) Clean Energy Systems Mendota.*

Schlumberger, Attachment F: Emergency and Remedial Response Plan. (2021). *Attachment F: Emergency and Remedial Response Plan 40 CFR 146.94(A) Clean energy Systems Mendota.*

Schlumberger, Attachment G: Construction Details Clean Energy Systems Mendota. (2021). *Attachment G: Construction Details Clean Energy Systems Mendota.*

Schlumberger, Attachment H: Financial Assurance Demonstration. (2021). *Attachment H: Financial Assurance Demonstration 40 CFR 146.85 Clean Energy Systems Mendota.*

Schlumberger, Class VI Permit Application Narrative. (2021). *Class VI Permit Application Narrative 40 CFR 146.82(A) Clean Energy Systems Mendota.*

Appendices

Figure 3. Typical form for groundwater sampling chain of custody.

Environmental Laboratory Accreditation Program (ELAP)
P.O. Box 100, Sacramento, CA 95812

Application for Accreditation
Environmental Laboratory Accreditation Program

This application is for laboratories seeking accreditation under the California Environmental Laboratory Improvement Act (Chapter 4 commencing with Section 100825, Part 1, Division 101, of the California Health And Safety Code).

PART A - LABORATORY INFORMATION		
1. Type of Application: ☐ New ☐ Renewal ☐ Amendment Certificate No. Expiration Date:		
2. Name of Laboratory:		
3. Division:		
4. Laboratory Location / Address (Actual Location): Street:		
City:	State:	Zip:
Country:	Country Code:	
5. Laboratory Mailing Address (For mail delivery): Street:		
City:	State:	Zip:
Country:	Country Code:	
6. Laboratory Shipping Address (For sample delivery): Street:		
City:	State:	Zip:
Country:	Country Code:	
7. Telephone #:	**8.** FAX #:	
9. E-Mail Address:	**10.** Web Site:	
11. County (CA Only):	**12.** Water Quality Control Board Region #:	
13. Description of Laboratory Type (Check one): ☐ Commercial ☐ Federal ☐ State ☐ County	☐ City ☐ Public water system ☐ Public wastewater system ☐ Recycling Facility	☐ Academic Institute ☐ Hospital or health care ☐ Industrial (with NPDES permit only) ☐ Other (describe):
14. Laboratory Director:	Telephone #:	
15. Contact Person:	Telephone #:	
16. Mail Recipient Name:		
17. Owner / Agents Name:		

Page **1** of **6** Effective Date: 083019

Environmental Laboratory Accreditation Program (ELAP)
P.O. Box 100, Sacramento, CA 95812

18. For Mobile Laboratories:		
Vehicle Make: ______________	Model: ________________	Vehicle ID #: ________________
Vehicle License #: ________________	State of Registration: _____	

PRIVACY NOTIFICATION

The information in Part B (Personnel Qualifications) of this application is requested by the State Department of Public Health in compliance with the Information Practices Act of 1977. The authority for maintaining the requested information is California Code of Regulations, Title 22, Sections 64485 and 67605. This information is mandatory. Failure to provide all the necessary information may result in denial of the application for certification. The purpose of the personnel information is to verify the personnel qualifications required for the laboratory director and principal analyst(s). This information will not be disclosed except in accordance with the Information Practices Act of 1977. For more information or access to your records, contact ELAP.

PART B – PERSONNEL QUALIFICATIONS: LABORATORY DIRECTOR				
1. Name (Last, First, Middle Initial):				
2. Title:				
3. Education:				
Month/Year From - To	College/University	Major	Degree	Year Completed
4. Technical Training:				
Month/Year From - To	Technical Trade or Service School	Subject Certificate	Year Completed	
5. Relevant Experience: (Last 5 years)				
Month/Year From - To	Name and Address of Employer		Job Title	
6. Briefly describe your experience relevant to this employment on a separate sheet of paper. Be sure to identify the laboratory person's name and position.				

Page **2** of **6** Effective Date: 083019

Environmental Laboratory Accreditation Program (ELAP)
P.O. Box 100, Sacramento, CA 95812

7. Analyst Certificate(s):	
☐ California-Nevada Section of the American Water Works Association (CA-NV/AWWA)	
Grade:	Expiration Date:
☐ California Water Environment Association (CWEA)	
Grade:	Expiration Date:

Please make photocopies of this form and provide the information for additional personnel.

PART B – PERSONNEL QUALIFICATIONS: PRINCIPAL ANALYST

1. Name (Last, First, Middle initial):

2. Title:

☐ Supervisor of Section: Operates Device:

3. Education:

Month/Year From - To	College/University	Major	Degree	Year Completed

4. Technical Training:

Month/Year From - To	Technical Trade or Service School	Subject Certificate	Year Completed

5. Relevant Experience: (Last 5 years)

Month/Year From - To	Name and Address of Employer	Job Title

6. Briefly describe your experience relevant to this employment on a separate sheet of paper. Be sure to identify the laboratory person's name and position.

7. Analyst Certificate(s):	
☐ California-Nevada Section of the American Water Works Association (CA-NV/AWWA)	
Grade:	Expiration Date:
☐ California Water Environment Association (CWEA)	
Grade:	Expiration Date:

Page **3** of **6** Effective Date: 083019

Environmental Laboratory Accreditation Program (ELAP)
P.O. Box 100, Sacramento, CA 95812

PART C – FIELDS OF TESTING

Check the appropriate box(es) for the Fields of Testing (FoTs) for which your laboratory requests certification.

☐	E101	Microbiology of Drinking Water
☐	E102	Inorganic Chemistry of Drinking Water
☐	E103	Toxic Chemical Elements of Drinking Water
☐	E104	Volatile Organic Chemistry of Drinking Water
☐	E105	Semi-volatile Organic Chemistry of Drinking Water
☐	E106	Radionuclides of Drinking Water
☐	E107	Microbiological Methods for Non-Potable Water and Sewage Sludge
☐	E108	Inorganic Constituents in Non-Potable Water
☐	E109	Metals and Trace Elements in Non-Potable Water
☐	E110	Volatile Organic Constituents in Non-Potable Water
☐	E111	Semi-volatile Organic Constituents in Non-Potable Water
☐	E112	Radionuclides in Non-Potable Water
☐	E113	Environmental Toxicity Methods
☐	E114	Inorganic Chemistry & Toxic Chemical Elements of Hazardous Waste
☐	E115	Extraction Test of Hazardous Waste
☐	E116	Volatile Organic Chemistry of Hazardous Waste
☐	E117	Semi-volatile Organic Chemistry of Hazardous Waste
☐	E118	Radionuclides in Hazardous Waste
☐	E120	Physical Properties of Hazardous Waste
☐	E121	Bulk Asbestos Analysis of Hazardous Waste
☐	E124	Organic Chemistry of Pesticide Residues in Food (measurements by MS techniques)
☐	E125	Organic Chemistry of Pesticide Residues in Food (excluding measurements by MS techniques)
☐	E126	Microbiological Methods for Ambient Water
☐	E127	Shellfish Sanitation
☐	E129	Parasites in Potable Water

Page **4** of **6** Effective Date: 083019

Environmental Laboratory Accreditation Program (ELAP)
P.O. Box 100, Sacramento, CA 95812

PART D – INVOICE FOR FEES
☐ Claim of Exemption from Fees: (attach written evidence for claim of exemption)
☐ *California County or City Public Health Laboratory established under, Health and Safety Code Section 101150*
☐ *Government Reference Laboratory as defined in, Health and Safety Code Section 100860 € & (g)*
☐ Not Exempt From Fees

The Basic Fee is $2268.00, and the Field of Testing Fee is $1021.00.

Basic Fee + Number of Fields of Testing Requested times the Field of Testing Fee = Total Fee

$2268.00 + ______________________ = $ __________________

Base Fee + (Number of FoTs X $1021) = Total Fee Amount

Enclose a check for the total fee, payable to "Environmental Laboratory Accreditation Program."

NOTE: Out of state laboratories – the cost of travel to visit a laboratory located outside the State of California will be determined and billed after completion of the site visit, Section 100860(b), Health and Safety Code.

PART E – QUALITY ASSURANCE MANUAL
Please submit your laboratory's manual for the in-house quality assurance program with this application by e-mail to: elapca@waterboards.ca.gov

PART F – FIELD OF TESTING WORKSHEET
Field of Testing (FoT) worksheets can be downloaded from https://www.waterboards.ca.gov/drinking_water/certlic/labs/fot_forms.html. Submit the completed electronic worksheets and signed hard copy via email to (elapca@waterboards.ca.gov).

PART G – OTHER PERTINENT INFORMATION (OPTIONAL)
Use a separate sheet of paper to provide any additional information about your laboratory that you feel may demonstrate laboratory competency, such as other certifications and proficiency testing programs in which your laboratory participates.

Environmental Laboratory Accreditation Program (ELAP)
P.O. Box 100, Sacramento, CA 95812

PART H – APPROVAL FOR SUBMISSION (This section must be completed and signed before the application will be accepted)	
TYPE OR PRINT - Name of Laboratory:	
Name of Owner or Owner's Agent:	
Signature:	Date:

Return the completed application, quality assurance manual, Field of Testing worksheets to: elapca@waterboards.ca.gov.

Page **6** of **6** Effective Date: 083019